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Static Seismic Analysis of RCC Building as per IS 1893:2002 by Using STAAD-Pro Software

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Abstract – *In this paper seismic response of (G+7)R.C. framed building is analyses for different load cases by using STAAD-Pro software as per IS1893:2002 part-1.This paper consider different seismic parameter like seismic zone, response reduction factor, importance factor & other parameters like rock/soil type, structure type, damping ratio etc. This paper provides complete guidelines for STAAD-Pro software analysis & STAAD –Pro gives the results after run analysis in the STAAD output viewer which shows joint displacements, support reactions, member forces base shear and lateral load.*

Keywords- Static analysis, IS 1893:2002, reinforced structure, Earthquake, STAAD-Pro, Seismic loads, multistory building, RCC building.

INTRODUCTION

From the history of earth, Earthquake is sudden violent shaking or Vibrations of the ground. Earthquake caused by tectonic movement in earth Crust and also caused by sudden slip on a fault or rupture of geological faults, But also by other events (natural & artificial causes) such as volcanic activity, Landslides, mine blasts and nuclear tests. In recent studies geologist claim that global warming is one of the Reason for seismic activity. According to these studies melting glaciers and Rising sea level disturb the balance of pressure on earth tectonic plates thus causing increase in frequency and intensity of earthquakes results in Damages structure & property of nation. Hence, earthquake is a major problem by development of nation & great Challenge for structural engineer to construct building in seismic region (Zones). Hence, structure should be analyzed for earthquake forces to avoid the damages.Generally Structure having two types of loading that is static loading and dynamic loading. Static loads are Constant and dynamic loads are change with time. In maximum civil buildings or structures only static loads are considered and dynamic loads are not calculated because of more complications in calculation. In this paper complete static analysis is performed by using STAAD-Pro software.

METHODOLOGY

Consider (G+7) storey building located in new Delhi zone IV, the soil conditions is medium stiff soil, entire building is supported on raft foundation, RC frame infill with brick masonry, lumped weight due to dead load is 12kN/m^2 on floors and 10kN/m^2 on roof, floors carry live load of 4kN/m^2 on floors and 1.5kN/m^2 on roof, span of building 5m in X and Z direction, Floor to floor height is 3.1m, bottom floor height is 4.2m, size of beam is assume to be as 0.35X0.45m And size of column as 0.35X0.5m, material assume to be concrete. All the supports are assigning as fixed supports,

- Lumped Weight:-A lumped mass is a load that can be applied to a node in a static stress, natural frequency (modal) or modal superposition analysis. A lumped mass can be used to resist the translation or rotation of a node.
- Seismic parameter:-
  1) Seismic zone IV, zone factor Z is 0.24 ………… (Table no. 2 of IS1893:2002 Part-1)
  2) Response reduction factor, R is 5 ………… (Table no. 7 of IS1893:2002 Part-1)
  3) Importance factor, I is 1.0 .………... (Table no. 6 of IS1893:2002 Part-1)

Here, I explain how to define IS1893:2002 Seismic loading definitions. Further we will apply that all loads to the buildings and analyses the building by using STAAD-Pro software.

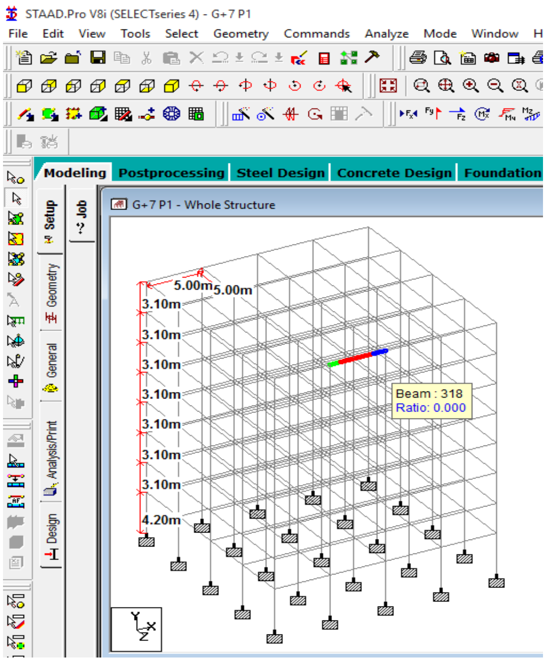


Fig. 1- fig shows the Structural model of building in STAAD-Pro software.

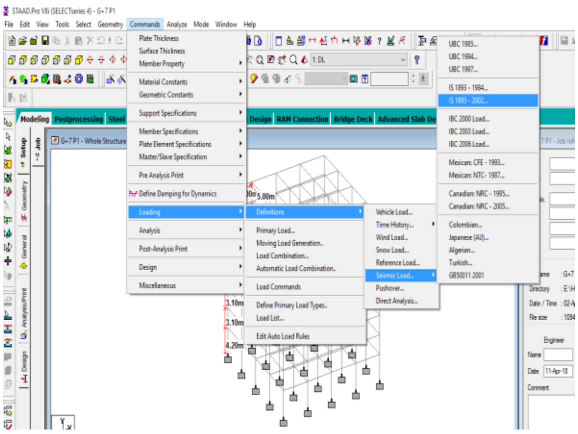


Fig. 2- fig shows the seismic definition

The natural vibration characteristics of a structure play a significant role in estimation of seismic behavior of a structure. The design guidelines of different countries also provide some estimate of the natural period by prescribing empirical expressions.

Since our building is made of moment resisting frame with break in fill panels, we should use empirical expression the fundamental natural period is as follows:

T=0.09h/sqrt (d)

…… (Clause 7.6.2 of IS 1893:2002)

By default STAAD-Pro calculates the fundamental natural period by using the expression. We will have to calculate natural period manually for this building using following equation:

T=0.075h ^ (0.75)

…… (Clause 7.6.1 of IS 1893:2002)

Hence approximate fundamental natural period in both X and Z direction is as follows:

T = 0.09(25.9) / sqrt (20)

T = 0.5212 sec… (Since X and Z direction value D = 20)

Add Damping Ratio as 0 to get the accurate result. In engineering, the damping is dimensionless measure describing how oscillations in a system decay after a disturbance.

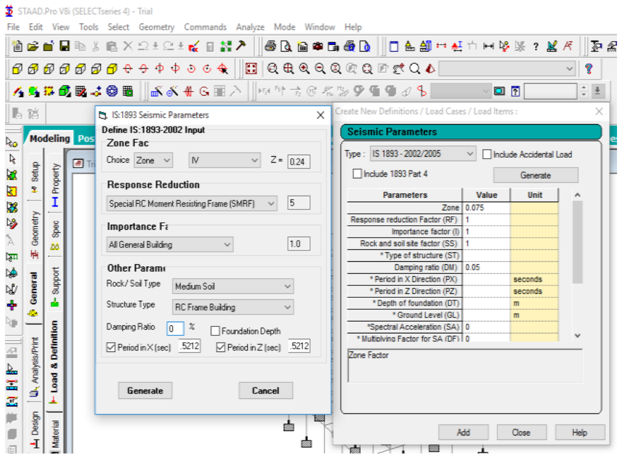


Fig. 3- fig shows the seismic parameter.

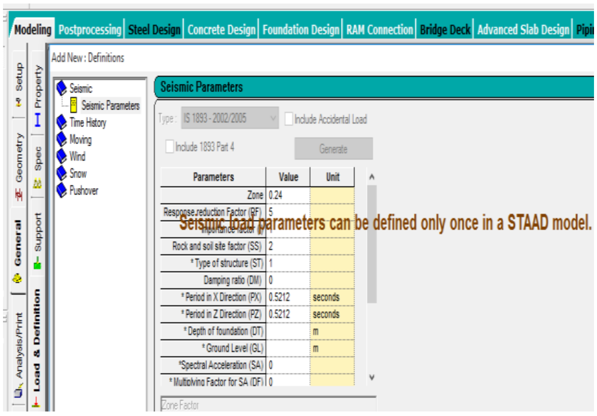


Fig. 4- fig shows the seismic parameter can be defined only once in STAAD model.

Seismic definition is generated to help STAAD-Pro to obtain the value for Ah

VB = Ah*W

Where,

VB = Seismic base shear,

Ah= Horizontal acceleration spectrum value as per 6.4.2 of IS 1893:2002

W = Seismic weight of building.

To help STAAD-Pro to calculate W (Seismic weight)

We will define floor weight in the building

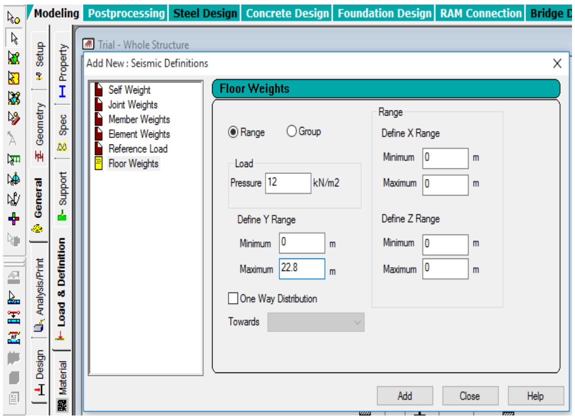


Fig. 5- fig shows the seismic floor weight of building for dead load.

For roof only

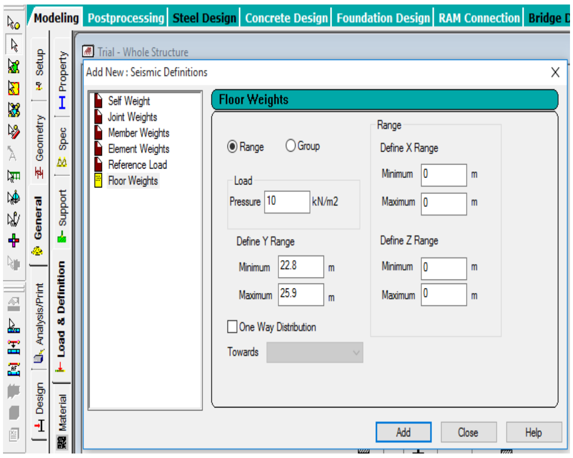


Fig. 6- fig shows the seismic floor weight of building for dead load.

Now floor carry a live load 4 KN/m^2.Since the value of live load is more then 4kN/m^2, 50% of live load will be lumped on floors, hence 50% of live load that will be 2kN/m^2

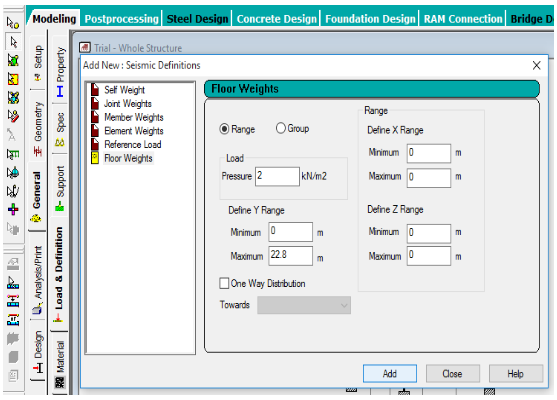


Fig. 7- fig shows the seismic weight of building for live load.

This completes the seismic definition as per IS 1893-2002.

Defining Dead Load Case- First of all we will have to define earth quake load case.

Dead load cases: - For floors shown in fig.

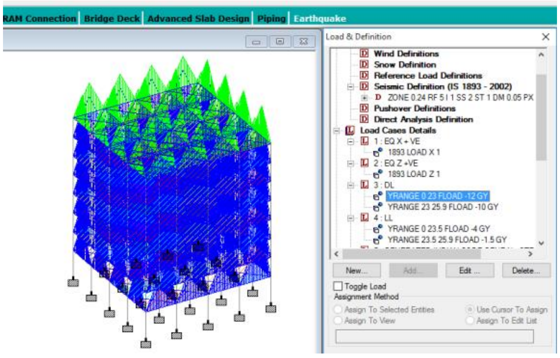


Fig. 8- fig shows the D.L. case for floors.

Live Load case: -for Floors

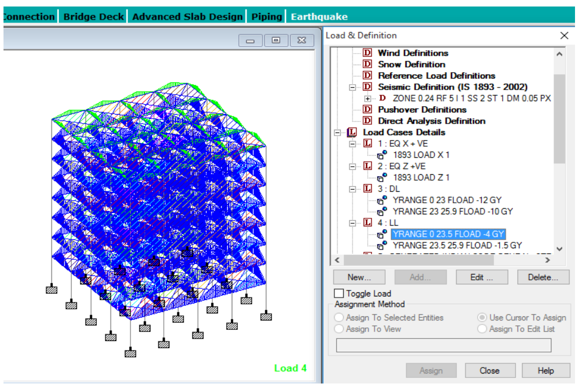


Fig. 9- fig shows the L.L. case for floors.

Before applying auto load combinations we will have to define analysis and print data command between load case 1 and 2 and then load case 2 and 3.

This will help STAAD-Pro to calculate loads for load cases 1 and 2 in x direction and z direction before doing the combinations. After Perform analysis- we will use the "Change" command to reset Stiffness Matrix.

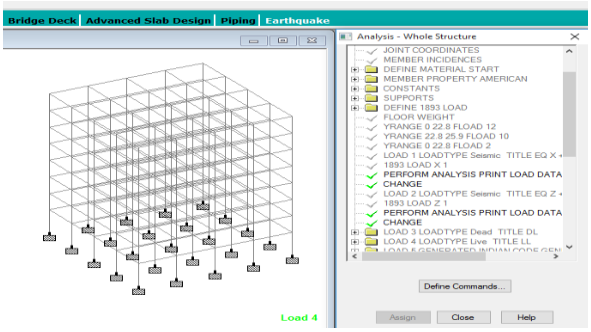


Fig. 10- fig shows perform analysis.

Partial safety factors for limit state design of reinforced concrete structures, the following load combinations shall be accounted for:

1) 1.5(DL + LL)
2) 1.2(DL + IL +_ EL)
3) 1.5(DL +_EL)
4) 0.9 DL +_ 1.5 E

……. (clause 6.3.1.2 of IS1893:2002Part-1)

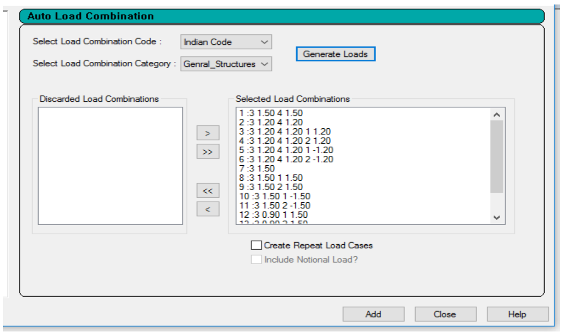


Fig. 11- fig shows the auto load combination as per IS 1893:2002

By check in "Create Repeat load cases" it will create auto load combinations with repeat command, which help STAAD-Pro to analyze building with simultaneous effects of all load cases.

Now again apply command "Perform Analysis" then Click "Post print" from Analysis Toolbar. Now Click "Define command"

Add load cases from 5 to 12.So STAAD-Pro consider only this load cases to print data.

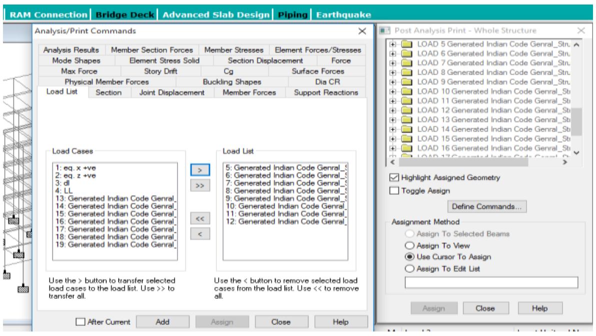


Fig. 12- fig shows the add load list 5-12

Likewise add "Joint displacement", Support reactions" and Member forces" also

Assign Joint displacement command to "Assign to view"

Assign Support reactions command to "Assign to view"

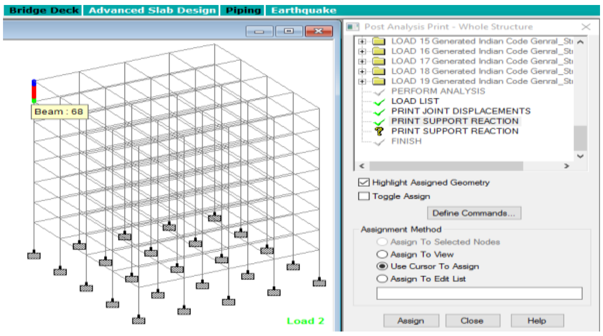


Fig. 13- fig shows adding joint displacement, support reaction and member forces for assigning.

Assign Member forces command to Columns at bottom only shown in fig:-

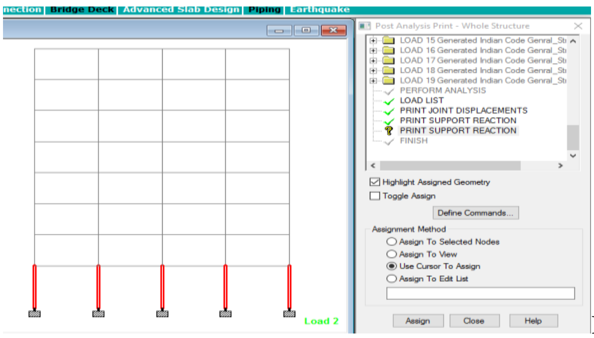


Fig. 14- fig shows the Assign member forces

Now "Run Analysis".

STAAD-Pro gives the results after run analysis in STAAD output viewer which shows the joint displacement, support reactions and member forces as shown in fig.

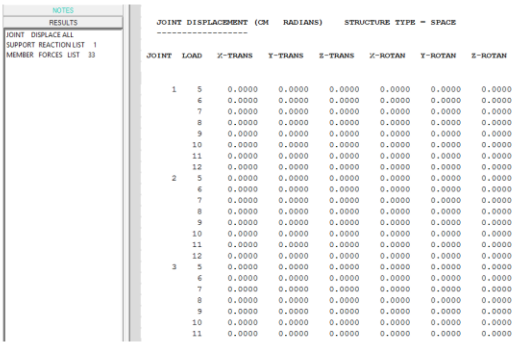


Fig. 15- fig shows the Joint displacement of first 5 joint

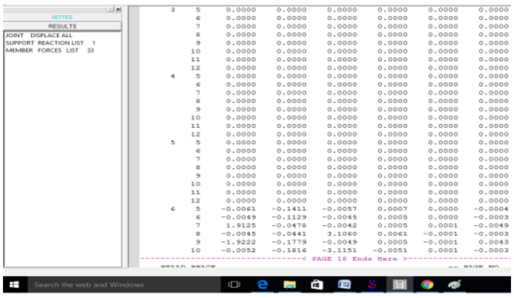


Fig. 16- fig shows the Joint displacement of first 5 joint

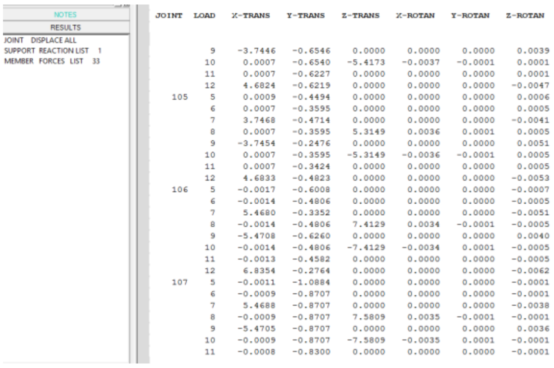


Fig. 17- fig shows the Joint displacement

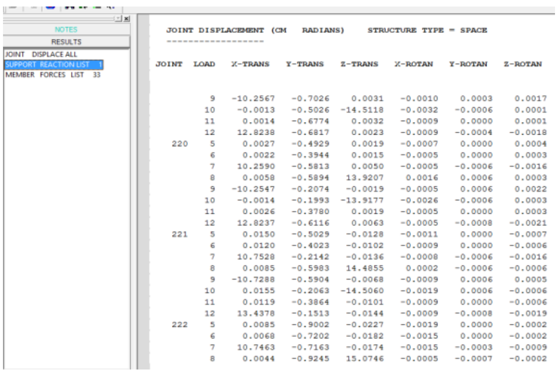


Fig. 18- fig shows the Joint displacement

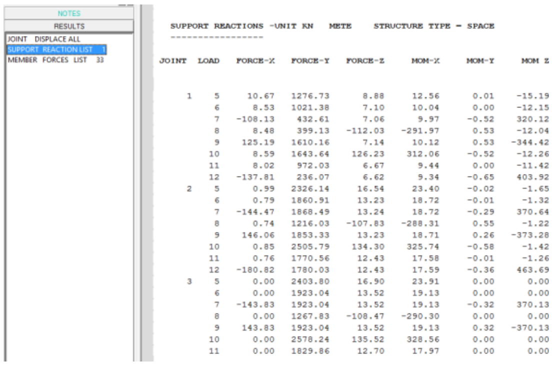


Fig. 19- fig shows the Support reaction

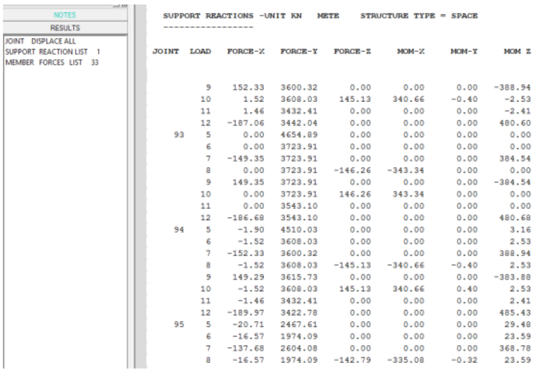


Fig. 20- fig shows the Support reaction

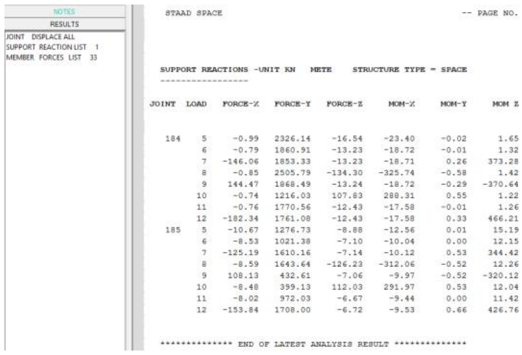


Fig. 21- fig shows the Support reaction

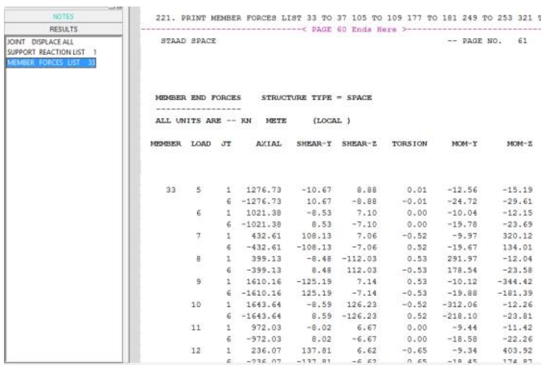
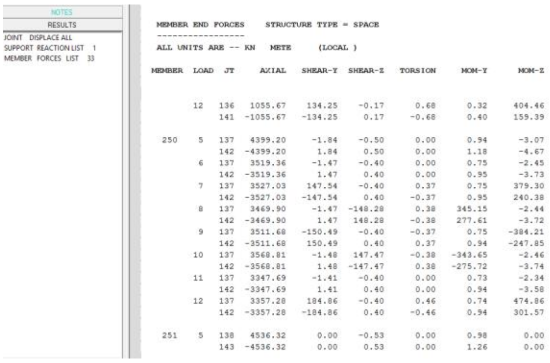


Fig.22- fig shows the Member forces



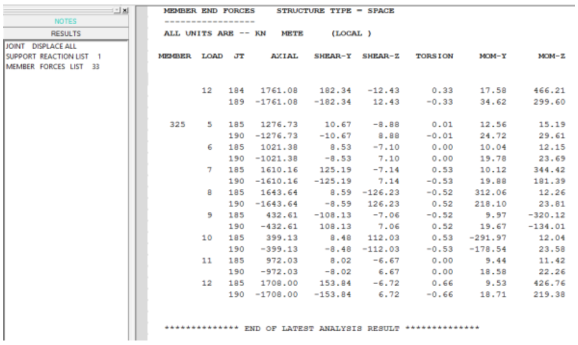
NOTES
RESULTS
JOINT DISPLACE ALL
SUPPORT REACTION LIST 1
MEMBER FORCES LIST 33

MEMBER END FORCES STRUCTURE TYPE = SPACE

ALL UNITS ARE -- KN METE (LOCAL)

MEMBER	LOAD	JT	AXIAL	SHEAR-Y	SHEAR-Z	TORSION	MOM-Y	MOM-Z
	12	136	1055.67	134.25	-0.17	0.68	0.32	404.46
		141	-1055.67	-134.25	0.17	-0.68	0.40	159.39
250	5	137	4399.20	-1.84	-0.50	0.00	0.94	-3.07
		142	-4399.20	1.84	0.50	0.00	1.18	-4.67
	6	137	3519.36	-1.47	-0.40	0.00	0.75	-2.45
		142	-3519.36	1.47	0.40	0.00	0.95	-3.73
	7	137	3527.03	147.54	-0.40	0.37	0.75	379.30
		142	-3527.03	-147.54	0.40	-0.37	0.95	240.38
	8	137	3469.90	-1.47	-148.28	0.38	345.15	-2.44
		142	-3469.90	1.47	148.28	-0.38	277.61	-3.72
	9	137	3511.68	-150.49	-0.40	-0.37	0.75	-384.21
		142	-3511.68	150.49	0.40	0.37	0.94	-247.85
	10	137	3568.81	-1.48	147.47	-0.38	-343.65	-2.46
		142	-3568.81	1.48	-147.47	0.38	-275.72	-3.74
	11	137	3347.69	-1.41	-0.40	0.00	0.73	-2.34
		142	-3347.69	1.41	0.40	0.00	0.94	-3.58
	12	137	3357.28	184.86	-0.40	0.46	0.74	474.86
		142	-3357.28	-184.86	0.40	-0.46	0.94	301.57
251	5	138	4536.32	0.00	-0.53	0.00	0.98	0.00
		143	-4536.32	0.00	0.53	0.00	1.26	0.00

Fig. 23- fig shows the Member forces



NOTES
RESULTS
JOINT DISPLACE ALL
SUPPORT REACTION LIST 1
MEMBER FORCES LIST 33

MEMBER END FORCES STRUCTURE TYPE = SPACE

ALL UNITS ARE -- KN METE (LOCAL)

MEMBER	LOAD	JT	AXIAL	SHEAR-Y	SHEAR-Z	TORSION	MOM-Y	MOM-Z
	12	184	1761.08	182.34	-12.43	0.33	17.58	466.21
		189	-1761.08	-182.34	12.43	-0.33	34.62	299.60
325	5	185	1276.73	10.67	-8.88	0.01	12.56	15.19
		190	-1276.73	-10.67	8.88	-0.01	24.72	29.61
	6	185	1021.38	8.53	-7.10	0.00	10.04	12.15
		190	-1021.38	-8.53	7.10	0.00	19.78	23.69
	7	185	1610.16	125.19	-7.14	0.53	10.12	344.42
		190	-1610.16	-125.19	7.14	-0.53	19.88	181.39
	8	185	1643.64	8.59	-126.23	-0.52	312.06	12.26
		190	-1643.64	-8.59	126.23	0.52	218.10	23.81
	9	185	432.61	-108.13	-7.06	-0.52	9.97	-320.12
		190	-432.61	108.13	7.06	0.52	19.67	-134.01
	10	185	399.13	8.48	112.03	0.53	-291.97	12.04
		190	-399.13	-8.48	-112.03	-0.53	-178.54	23.58
	11	185	972.03	8.02	-6.67	0.00	9.44	11.42
		190	-972.03	-8.02	6.67	0.00	18.58	22.26
	12	185	1708.00	153.84	-6.72	0.66	9.53	426.76
		190	-1708.00	-153.84	6.72	-0.66	18.71	219.38

************** END OF LATEST ANALYSIS RESULT **************

Fig. 24- fig shows the Member forces

CONCLUSION

The response of (G+7) storey RC building under seismic load as per IS1893:2002 (Part-1) by using software STAAD -Pro has been studied. The building is modeled as 3D space frame using STAAD-Pro software. The building for different load cases such as DL, LL and Seismic load has been analyzed. This analysis provides complete guidelines for STAAD-Pro software analysis of static method. STAAD-Pro gives result very quickly as compared to manual calculation. Also Base shear, Lateral load, Joint displacement, support reaction and member forces for all the joints of a building has been calculated and printed further. .

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